RAILROAD INSPECTOR FOR RAILROAD DEPARTMENT IN MALAYSIA

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ABSTRACT

This thesis is the design of an autonomous robot which this robot can detect defect on railroad to prevent the future accident. This final year project carry out by the author to fulfillment the requirement for award the degree of Bachelor Mechatronics Engineering. This designed robot which has two stages of development and included two models. The first model is for PSM 1 and the second is fully functional model is for PSM 2. Basically, the design of robot quite more interesting, modern, unique and environmental friendly which using Arduino Uno and Agilent Instrument as a platform. In this report, I had made entire analysis requirement, design circuit, check output and input data and other important parameters to realization the design of the working robot that can be implementation by railroad department. On the other hand, this report is to aim to provide objective and scope of the research, the literature review study, research methodology, and fabrication process with result analysis and conclusion as part requirement in submitted the report to PSM supervisor. Although railroad inspection and development is still new technology in Malaysia and no domestic consumption in this technology, but through this project can help the industry a step further. It is because this project can categorized as successful and working as expected. Finally, I wish this project can categorized on research and design development by interesting mechatronics student.

ABSTRAK

Kajian ini adalah reka bentuk robot autonomi dimana robot ini dapat mengesan kecacatan pada jalan kereta api untuk mencegah kemalangan masa depan. Projek tahun akhir yang dijalankan oleh penulis untuk memenuhi keperluan untuk anugerah ijazah Sarjana Muda Kejuruteraan Mekatronik. Robot yang direka ini mempunyai dua peringkat pembangunan dan termasuk dua model. Model pertama adalah untuk PSM 1 dan yang kedua ialah model berfungsi sepenuhnya adalah untuk PSM 2. Mesra Pada asasnya, reka bentuk robot agak lebih menarik, moden, unik dan alam sekitar yang menggunakan Arduino Uno dan Agilent Instrumen sebagai platform. Dalam laporan ini, saya telah membuat analisis keperluan keseluruhan, reka bentuk litar, daftar output dan input data dan parameter lain yang penting untuk merealisasikan reka bentuk robot kerja yang boleh dilaksanakan oleh jabatan kereta api. Sebaliknya, laporan ini adalah untuk bertujuan untuk menyediakan objektif dan skop penyelidikan, kajian kajian literatur, kaedah penyelidikan, dan proses fabrikasi dengan analisis keputusan dan kesimpulan sebagai keperluan bahagian dalam mengemukakan laporan kepada penyelia PSM. Walaupun pemeriksaan dan pembangunan kereta api merupakan teknologi baru di Malaysia dan tiada penggunaan domestik dalam teknologi ini, tetapi melalui projek ini dapat membantu industri langkah seterusnya. Ia adalah kerana projek ini boleh dikategorikan sebagai berjaya dan sibuk bekerja seperti yang diharapkan. Akhir sekali, saya berharap projek ini boleh dikategorikan kepada penyelidikan dan pembangunan reka bentuk oleh pelajar mekatronik menarik..

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LIST OF SYMBOLS

π : 3.142

° : Degree

Pps : Pulse/second

µs : Micro second

ms : Mili second

V : Voltage

A : Amphere

LIST OF ABBREVIATIONS

DC	: Direct Current
U2781A	: USB Modular Product Chassis
U2701A	: USB Modular Oscilloscope
U2352A	:USB Modular DAQ
U2901A	:DAQ Terminal Block
E3631A	: Triple Output DC Power Supply
FYP	:Final Year Project
FKP	:Faculty of Manufacturing
UMP	:University Malaysia Pahang
ULN	:Upper Limits of Normal
IC	: Integrated Circuit
LED	: Light Emitting Diode
rpm	: radius per minit

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter describes the background of railroad inspector, problem statement of this project, the objectives of research, scope of the research, significant of research and expected result for this project.

1.2 BACKGROUND OF STUDY

Transport is a key necessity for specialization that allows production and consumption of products to occur at different locations. Transport has throughout history been a spur to expansion as better transport leads to more trade. Economic prosperity has always been dependent on increasing the capacity and rationality of transport. But the infrastructure and operation of transport has a great impact on the land and is the largest drainer of energy, making transport sustainability and safety a major issue. In Malaysia, the rail transport occupies a prominent position in providing the necessary transport infrastructure to sustain and quench the ever-burgeoning needs of a rapidly growing economy. Today, Malaysia possesses the fifth largest railway network in the world and development to make the trains as the main transportation become true.

In era for development train as a main transportation, one horrific accident was report by BERNAMA which 2 person passenger was killed in train accident. According to us, incident at about 3:45 pm Wednesday, leaving KTM for services between the city and the east coast of the southern sector breakdown. In the incident,

a locomotive driver, Yahya Osman, 40, died at the scene due to severe injuries and nine wounded mild outpatient treatment Tuanku Ja'afar Hospital here and one of them admitted. During the incident, a train with eight carriages carry 258 passengers travelling from Butterworth, Penang to Singapore.

Figure 1.1: Horrific Accident [1]

On this tragedy, two cranes from Gemas and Falim depot, Ipoh used to work on that. Carriages issued Seremban will be pulled into the station. Both the victim, Chong Wah Sin, 42, who was injured in the left toe and back of the body as well as a woman Chia Lian Heng, 73, was injured in the head, respectively warded at the hospital 4B and 8B.

Another case was record by Green Blog with their title "Tragedy Back To Village" which incident occurred at 6:45 am at the Kampung Sungai Yu between Kuala Lipis and Gua Musang Station when the Express Wau from Kuala Lumpur to Tumpat in the journey took nearly 1,000 passengers aboard the 14 carriages to go home to celebrate Aidilfitri in the village. Reliable two-class passenger coaches and wagons bed nearly 100 passengers boarded at the back of the front carriages disconnected from the connection, causing it to skid before it overturned on the hillside.

Figure 1.2: Two carriages derailed in Kampung Sungai Yu, Gua Musang [2]

A total of 11 passengers were injured, eight more severe, including a wound in the face while the other two broken arms and a broken hip, and was rushed to Merapoh Health Center for treatment. From that, one smart step have to done quickly to avoid this problem will not happen again.

The interesting statement for both this resource is the accident stems from railroad problem which the train out from the railroad. According to the resource, two major problem that always have been face is crack and loosening bolt on railroad. These conditions of railroad always occur because the temperature on railroad always changes between hot and cold. From that, the microstructure of railroad also changed to brittle and easy to crack and loosening bolt.

Table 1.1: Condition of railroad that can cause accidents [3]

Figure 1.3: Loosening bolt

Figure 1.4: Crack on railroad

Figure 1.5: Non-junction on track

Figure 1.6: Serious crack on railroad

Cracks in rails have been identified to be the main cause of derailments in the past, yet there have been no cheap automated solutions available for testing purposes. Hence, owing to the crucial repercussions of this problem, design on implementing an efficient and cost effective solution suitable for large scale application. Since the railway was invented, rail maintenance had always been a problem crack or damage rail could lead derailment.

The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and of course, the lack of proper maintenance of rails which have resulted in the formation of cracks in the rails and other similar problems caused by anti-social elements which jeopardize the security of operation

of rail transport. In the past, this problem has lead to a number of derailments resulting in a heavy loss of life and property.

High safety standards required in the management of railroad lines demand the inspection of railway wheels directly after production in order to detect the presence of surface cracks and bolt loosening that could seriously affect the integrity of the railway, and therefore passenger's safety.

1.3 PROBLEM STATEMENT

Defect in railroad track are responsible for several incidents every year resulting in injuries, fatalities, infrastructure cost, environment damage, loss of use, etc. This case was expose by newspaper, internet, blog, radio, etc which according to us, they was record that the problem stems from railroad. As a result, there is a continuous need for inspection and maintenance of these track, with human inspectors are performing track inspection. Reveals the mind for several kilometer just for checking the defect on railroad is not easier jobalthough their effort is very thorough, the process can be extremely tedious, demanding, and time consuming. It also can provide negligence during checking process and the effect is there are several defect on railroad is failed to detect.

The purpose of this project is to design an autonomous robot platform which travel on railroads tracks and will identify defect on railroad track. Cracks in rails have been identified to be the main cause of in the past, yet there have been no cheap automated solutions available for testing purposes. Hence, owing to the crucial repercussions of this problem, design an efficient and cost effective solution suitable for large scale application. The system can be implemented in the long run to facilitate better safety standards and provide effective testing infrastructure for achieving better results in the future.

1.4 RESEARCH OBJECTIVES

To design of a working autonomous robot on following:

i. To develop system for detect crack

By identify the crack on railroad, the future accident can be prevent better safety standards and provide effective testing infrastructure for achieving better results in the future.

ii. To develop the system that gives a warning of surface crack to prevent possible future accident.

The principal problem is has been the lack of cheap and efficient technology to detect problems in the rail track. This system is more unique, environmental friendly, inexpensive material and component, and the best thing is there no company that has been develop this system.

iii. To build working of railroad inspector

System must be working perfectly to detect defect on railroad especially crack because this is major that have been face by train railroad department.

1.5 RESEARCH QUESTION

There are several techniques to solve this issue that depend on the situation.

i. How to detect the defect on railroad track

There are several technique for solve this issue as used by sophisticated country like United State(US), Japan, Britain, German, China, etc. which they are develop various technique like Ultrasonic inspection, Eddy Current technique, Laser checking and Magnetic Particle Inspection (MPI). All of this technique has their own pro and

contra thus the development on this technique always continues repeatedly.

ii. What are the system that used to detect defect on railroad

By using the components that already available, one system that known as ultrasonic system. The theory behind ultrasonic ranging is quite simple. Typically a short ultrasonic burst is transmitted from the transmitter. When there is an object in the path of the ultrasonic pulse, some portion of the transmitted ultrasonic wave is reflected and the ultrasonic receiver can detect such echo. By measuring the elapsed time between the sending and the receiving of the signal along with the knowledge of the speed of sound in the medium, the distance between the receiver and the object can be calculated. This system need to combine with other technology from Agilent.

1.6 SCOPE OF RESEARCH

The scope is depend the system of autonomous robot that will be develop.

i. To choose the suitable electronic items for build up the autonomous robot

Electronics component have their own characteristics for designing circuit process to avoid this component is burn out during attach on the circuit

ii. To recognize all autonomous robot application and limitation and also to define their classifications

The autonomous robot has their own limitation than other sophisticated system that develops by other country.

iii. To choose the suitable design for build up the autonomous robot

The design of autonomous robot should be taken in terms of dimension of robot, it because the circuit, battery and motor will be place on it platform.

1.7 SIGNIFICANT OF RESEARCH

After this project has been done, all of the knowledge could be apply either in scientifically. In addition, when something knowledge that most of us have then apply into several application it would give us a lot of good implications such as to create a self-confidence. Other than that, by invention may give a lots of attraction to ourselves compared just learning the theoretical of some knowledge. There are several principle and theory that involve with my autonomous robot like knee voltage, semiconducting material doped with impurities to create a p-n junction, forward and reverse bias concept.

1.8 DEFINITION OF TERM

Railroad is a permanent way, is the structure consisting of the rails, fasteners, sleepers and ballast (or slab track), plus the underlying sub grade. A road composed of parallel steel rails supported by ties and providing a track for locomotive-drawn trains or other wheeled vehicles. Transportation system made up of metal rails which is designed to allow trains to maneuver on the tracks from one location to the next. The most recognized railroad system is Amtrak, which travels throughout the United States and Canada. Most railroads with heavy traffic use continuously welded rails supported by sleepers (ties) attached via base plates which spread the load. A plastic or rubber pad is usually placed between the rail and the tie plate where concrete sleepers are used.

Inspector is most generally, an organized examination or formal evaluation exercise and critical appraisal involving examination, measurement, testing, gauging, and comparison of materials or items. An inspection determines if the material or item is in proper quantity and condition, and if it conforms to the applicable or specified requirements. In engineering activities inspection involves the

measurements, tests, and gauges applied to certain characteristics in regard to an object or activity. The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets.

Railroad Inspector is an autonomous robot that functions for detect the defect on railroad with automatically and sent data to USB Modular Oscilloscope U2701A. This robot was using ultrasonic sensor for detect the defect and travel from one station to other station for checking process. Simultaneously, this autonomous robot will stop from one station to other station for charging process before continue the checking process. High pulse on oscilloscope is meaning defect on railroad was detected.

1.9 EXPECTED RESULT

The expected result for developed system used for surface defect detection on railway wheels based on transmit and receive ultrasonic system that guide by Agilent technology. The circuit will be check by Agilent equipment to check the output from the circuit and give the maximum protection for the robot with this system it is possible to on-line detect the surface on railway wheels. The presented system is as a part of technology on inspection line and can be easily modified for special desired industrial applications. The department of railroad the significance and quality of data information. After the device being implemented, the department of railroad track can be easier to define the crack on railroad and it can be save the money to hire the worker to make the checkup of railroad problem. It also can be safety purpose and reduce the time of inspection.

1.10 LAYOUT OF THESIS

The overall content of this proposal will consist of five chapters. The first chapter is discussing about the introduction of the topic followed by the theory and literature review will be in chapter two. Discussion and explanation of the research methodology for all the methods and the components that require that require for mechanical design will be in chapter three. In chapter four, the content are about the

results and discussion for the project. Last but not least, the conclusion and recommendation for the project will be in chapter five.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter to describe the literature review research for final year project on journal, book and internet sources. The resources need to record to ensure that resources are properly taken as a reference. More accident was report by newspaper, television, radio, blog and the rate of increase in more serious cases reported. However, the train accident and incident rate in railroad yards far exceeds the rates across the entire railroad industry (Reinach and Gertler, 2002). Train accidents include collisions and derailments that involve the operation of on-track equipment and that meet certain reporting thresholds set by the Federal Railroad Administration (FRA, 2003).

Train incidents include employee injuries that involve the movement of on-track equipment and that meet certain reporting criteria (FRA, 2003). In fact, worsen the human error in the detection of defects in rail can invite consequences on the passenger train. In fact, human error in industrial environments and transportation systems is much more complicated to decode than simply blaming the operator. As Reason (1997, p. 126) notes, ". . . human error is a consequence not a cause. Errors . . are shaped and provoked by upstream workplace and organizational factors. Identifying an error is merely the beginning of the search for causes, not the end . . . Only by understanding the context that provoked the error can we hope to limit its recurrence."

2.2 WHAT IS RAILROAD INSPECTOR

Railroad inspector is an autonomous robot for detect defect on railroad and sent coordinate location in longitude on phone and latitude for prevent the future accident with automatically. Defect on railroad will happen the corrugation does not compromise rolling safety, but has an adverse effect on track element and rolling stocks by increasing noises emissions, loading and fatigue (Bohmer and Klimpel, 2002). Its occurrence is increasing on high speed passenger lines, mixed and heavy haul railways and can lead to expensive rail grinding in the attempt to remove it, premature removal of the rails and complete rail failure.

Nowadays, maintenance issues are becoming overwhelming because of the increase of operating loads, traffic, and high-speed trains. Therefore, maintenance means prevention of catastrophic rail failure to avert loss of rolling material as well as of lives. Since 1923 with the invention of the car inspection for detect rail flaw have been the most common way to inspect railroads (Abbaszadeh, 2003).

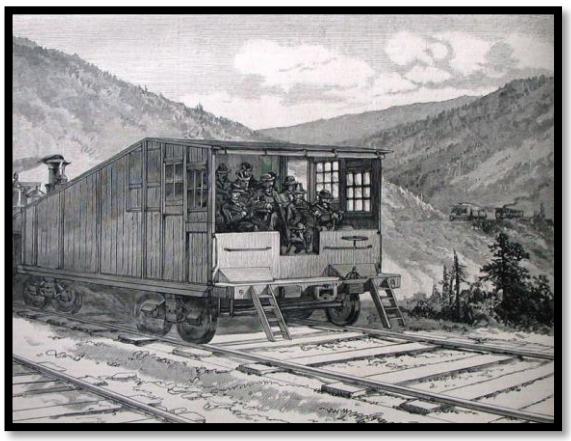

Figure 2.1: An Inspection Car on the Pennsylvania Railroad [4]

2.3 WHAT IS ULTRASONIC SYSTEM

There are several technique for detect defect on railroad that depend on situation and form structure condition on earth. Developed foreign country have develop various technique and modern for solve this issue. One of the most popular methods is ultrasonic inspection which this system is common technique in the rail industry in many foreign countries. Ultrasonic techniques scan railhead through ultrasonic beams and detect the return of reflected or scattered energy using ultrasonic transducers (Erazo, Baumert and Ladwig, 2004). It is a relatively well understood technique and was thought to be the best solution to crack detection. According toD.E. Bray, 1976 state that the ultrasonic non-destructive inspection has been significant contributor to the invention of railway accident for a number of years.

Ultrasonic frequencies, i.e. frequencies above 20 kHz, as these are rare in nature and thus the sensors are not disturbed. Moreover, man hears no such high frequencies. Incidentally, they are also completely harmless, because the sound energy is extremely small. Industrial ultrasonic sensors operate at frequencies of approximately 80-400 kHz, depending on what characteristics the sensor shall have (Evans, 2010). The greater the required measuring distance is, the lower frequencies must be used. Few creatures also make use of ultrasound for guidance. These are mainly the dolphin (in water) and the bat (in the air, as our sensors). Both have bad organs of sight and send ultrasonic waves up to 200 kHz *(*Symons, 1985). In addition, also other creatures can hear frequencies above 20 kHz although they probably don’t have a benefit for their orientation.

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